

2009 APPLICATION FORM

(required for each entry)

Complete this section for (check one): ☐ **Small Project** ☒ **Large Project**
☐ **Post-Design Solution** ☐ **Off System Project**

Job No. J4I1507 Route I29/I35 County / LPA Jackson/Clay

Description (attach separate sheet if necessary) See Attached Sheet

Complete this section for: **Process Improvement**

Process or Product _____

Description (attach separate sheet if necessary) _____

Project Leader Bryan Wilkerson - PCC

Key Team Members (include key personnel irrespective of employer-nine individuals maximum)

Pat Byrne - PCC Tom Skinner - MoDOT _____

Martin Furrer - PCC Kevin Irving - FHWA _____

Dan Brown - PCC _____

Project Budget:

Initial Cost / Estimate \$ 3,100,000 Final Cost / Award \$ 2,500,000

What would make this entry stand out from the rest of the entries when considering MoDOT's practical design philosophy? (In layman's terms - 200 words or fewer-attach separate sheet if necessary) _____

See Attached Sheet

Send entries to: MoDOT Design Division, ATTN: Joe Jones
1320 Creek Trail Dr., Jefferson City, Missouri 65109

ALL ENTRIES MUST BE RECEIVED NO LATER THAN CLOSE OF BUSINESS ON DECEMBER 1, 2008

Description

Located in Kansas City, the \$245 million kcICON design build project will reconstruct approximately 4 miles of Interstate I-29/I-35 and five interchanges. The scope of work also includes the reconstruction, rehabilitation, or replacement of twelve bridge structures, including the new cable stay Christopher S. Bond Bridge over the Missouri River. The design build, fixed price contract offered an unprecedented opportunity to develop innovative design solutions and cutting edge technology to provide the best value for every dollar spent on the project.

MoDOT Practical Design Philosophy

On the kcICON project, the use of base grouted drilled shafts for the bridge foundations not only made MoDOT history, but also provided a cost effective technical engineering solution that overcame a difficult geologic condition. This drilled shaft foundation technique also adds another cost effective design tool in the MoDOT Practical Design toolbox. The base grouting of the drilled shafts provides four additional design benefits. It compensates for any imperfections in base cleaning operations. The shaft end bearing resistance is preloaded so that base resistance (axial capacity) is mobilized under smaller vertical shaft displacements. The granular soils near the base and in the vicinity of the base of the drilled shaft are made more dense by increasing the confining stresses in the soil around the base of the drilled shaft and finally, during the pressure grouting of the drilled shaft, measurements of the shaft performance can be related to the axial resistance, providing a form of load verification for each production shaft. The historical implementation of the base grouted drilled shaft saved an estimated \$600,000 on the project.

November 30, 2008

Mr. Joe Jones, P.E.
Engineering Policy Administrator
105 West Capital
Jefferson City, Missouri 65102

RE: Practical Design – 2009 Awards for Excellence
Historical Use of Base Grouted Drilled Shafts for Bridge Foundations

General: Located in Kansas City, the \$245 million kcICON design build project involves the reconstruction of approximately 4 miles of Interstate I-29/I-35 and five interchanges. The scope of work also includes the reconstruction, rehabilitation, or replacement of twelve bridge structures, including the new cable stay Christopher S. Bond Bridge over the Missouri River. The contract was awarded to Paseo Corridor Constructors (PCC) in November 2007 and design will be completed in December 2008. Construction will be completed by July 2011. The design build, fixed price contract offered an unprecedented opportunity to develop innovative design solutions and apply cutting edge technology to provide the best value for every dollar spent on the project. For the first time in the State of Missouri, base grouted, slurry displacement drilled shafts were used for the foundations for the five river bridge approach bents. This innovative and historical foundation design is one of the more innovative design and construction techniques utilized on the project and is the subject of this submittal.

Background: The preliminary boring logs for the approach bents on the river bridge indicated a typical riverbed soil profile that consisted of a 100-foot layer of dense sand and gravel, underlain with hard shale bedrock. Initially, the design called for the foundations to be six foot diameter, steel cased, drilled shafts with 20-foot rock sockets acting as the load bearing element for the bent columns. After the project design was initiated, additional soil borings revealed that at Bent 5 there was a significant variation in the soil profile (See Exhibit 1A) as follows.

1. There is 130 feet of sand and gravel covering a thick stratum (20 feet) of cobbles and boulders, which lay on the top of the shale.
2. The top of sound bedrock was 15 feet lower than at the other bents.
3. The top of the shale was poor quality weathered shale requiring the drilled shafts to penetrate deeper into the shale bedrock.

Three drilled shaft alternatives were investigated to address the variable soil profile at Bent 5. The first alternative called for using a five foot diameter, permanently steel cased drilled shaft with a rock socket. The 192 foot long, cased drilled shaft required the shaft to be drilled through 130 feet of sand and gravel, 20 feet of cobbles and boulders, an additional 22 feet of weathered shale and fractured limestone then through 20 feet of sound rock developing the rock socket. This alternative was discarded due to the difficulty and uncertainty of being able to drill through the cobble field and placement of the permanent casing in the sound shale (See Exhibit 1A).

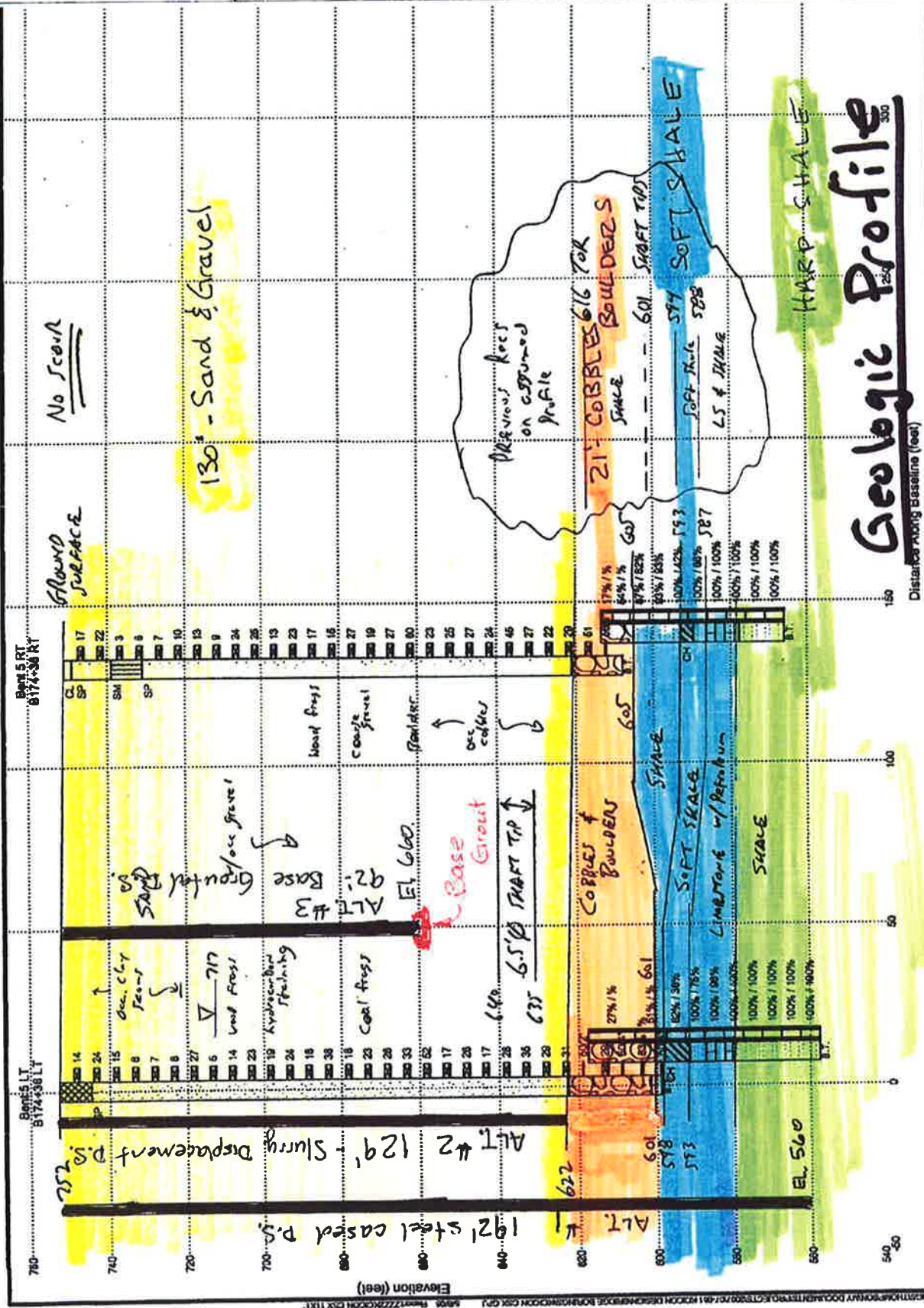
The second drilled shaft alternative required a 129 foot long by 6.5 foot diameter slurry displaced drilled shaft with the tip elevation placed just above the cobble field (See Exhibit 1A). This alternative relied on side friction with the in situ sand and gravel materials to carry the structural loads. The ability to construct this second alternative was unreliable, in that the porosity and cavities in the cobble field were unknown. It was difficult if not impossible, to determine if the bottom of the shaft could be adequately sealed to prevent the drilling slurry and the concrete for the drilled shaft from flowing into the cobble field. Because of the unknown conditions in the cobble field, this alternative was omitted from further consideration.

The third drilled shaft alternative is one that has never been used by MoDOT for bridge foundations. The historical and cutting edge foundation design solution required the installation of a 92-foot long by 6.5 foot diameter, based grouted, slurry displaced drilled shaft (See Exhibit 1A). The base grouting of the drilled shaft enhances the end bearing resistance, which substantially reduces the length of the shaft. Base grouting involves the delivery of grout under high pressure to the bottom of the drilled shaft after the shaft has been constructed through a distribution system tied into the reinforcing cage, as illustrated in Figure 1 and Figure 2.

The base grouting provides several benefits as follows:

1. The base grouting under pressure compensates for any imperfections in base cleaning operations.
2. The shaft end bearing resistance is preloaded so that base resistance (axial capacity) is mobilized under smaller vertical shaft displacements.
3. The granular soils at near the base and in the vicinity of the base of the drilled shaft are densified which increases the confining stresses in the soil around the base of the drilled shaft.
4. During the pressure grouting of the drilled shaft, measurements of the shaft performance can be related to the axial resistance, providing a form of load verification for each production shaft.

In short, the history making use of base grouted drilled shafts for the bridge foundations was a cost effective technical engineering solution that overcame a difficult geologic condition and significantly enhanced the reliability of each shaft. The estimated project cost savings is \$600,000.



NOTES:

Elevations and locations are approximate based on available data provided by project surveyor.

Qu = Unconfined Compression in psi

Exhibit - IA

DAN BROWN AND ASSOCIATES, PLLC
KACON RIVER BRIDGE
SUBSURFACE CROSS-SECTION

Scale: 1" = 25' Vertical, 1" = 30' Horizontal

By: WST Date: 5/5/2008

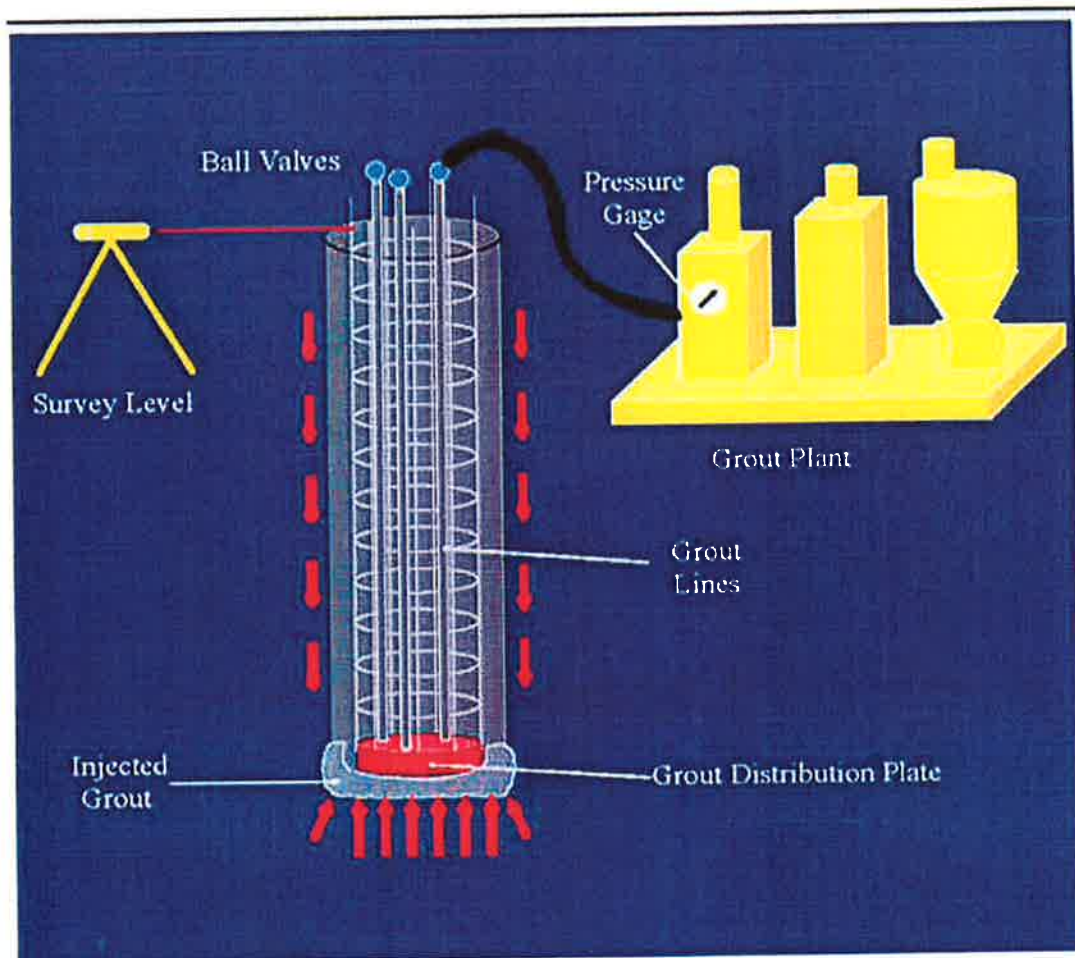


Figure 1 Schematic Diagram of Base Grouting

Schematic Diagram of Construction Sequence For Bent 5

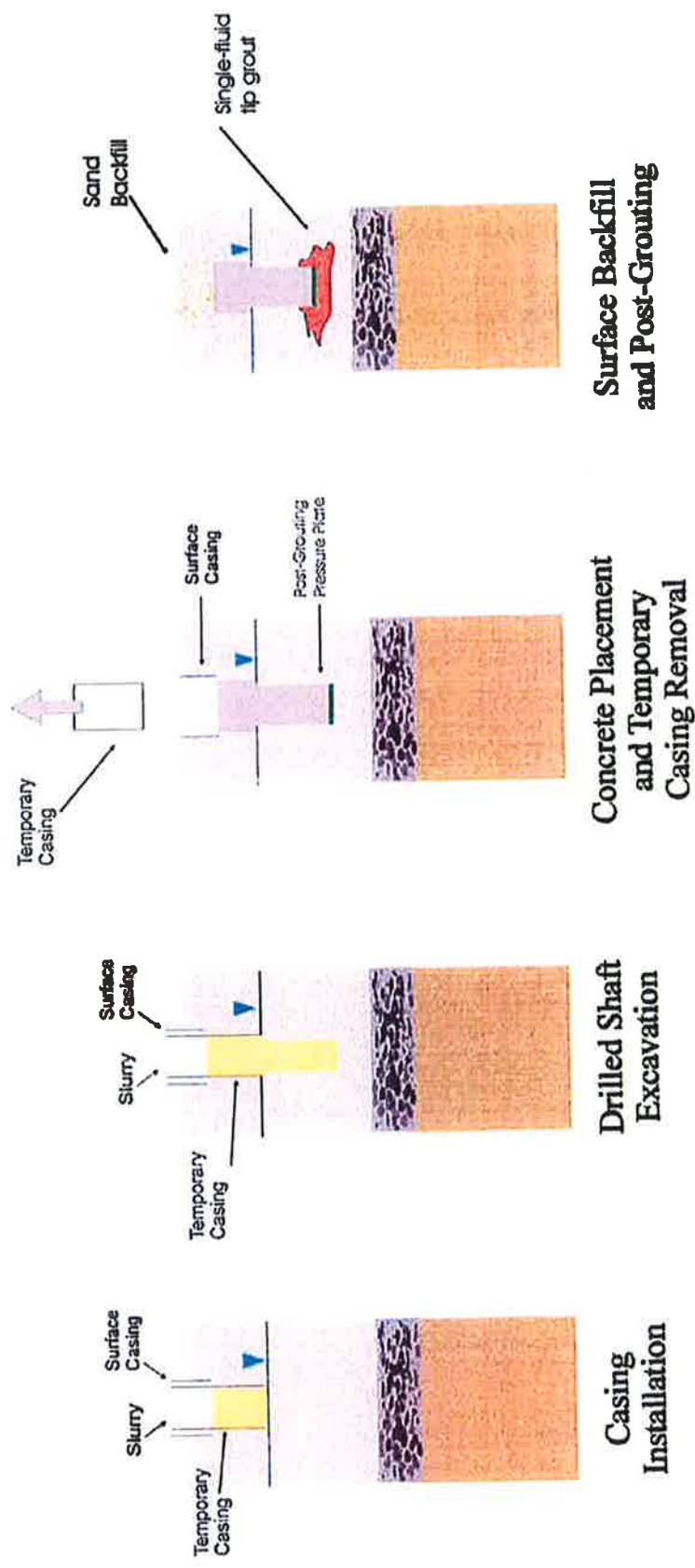
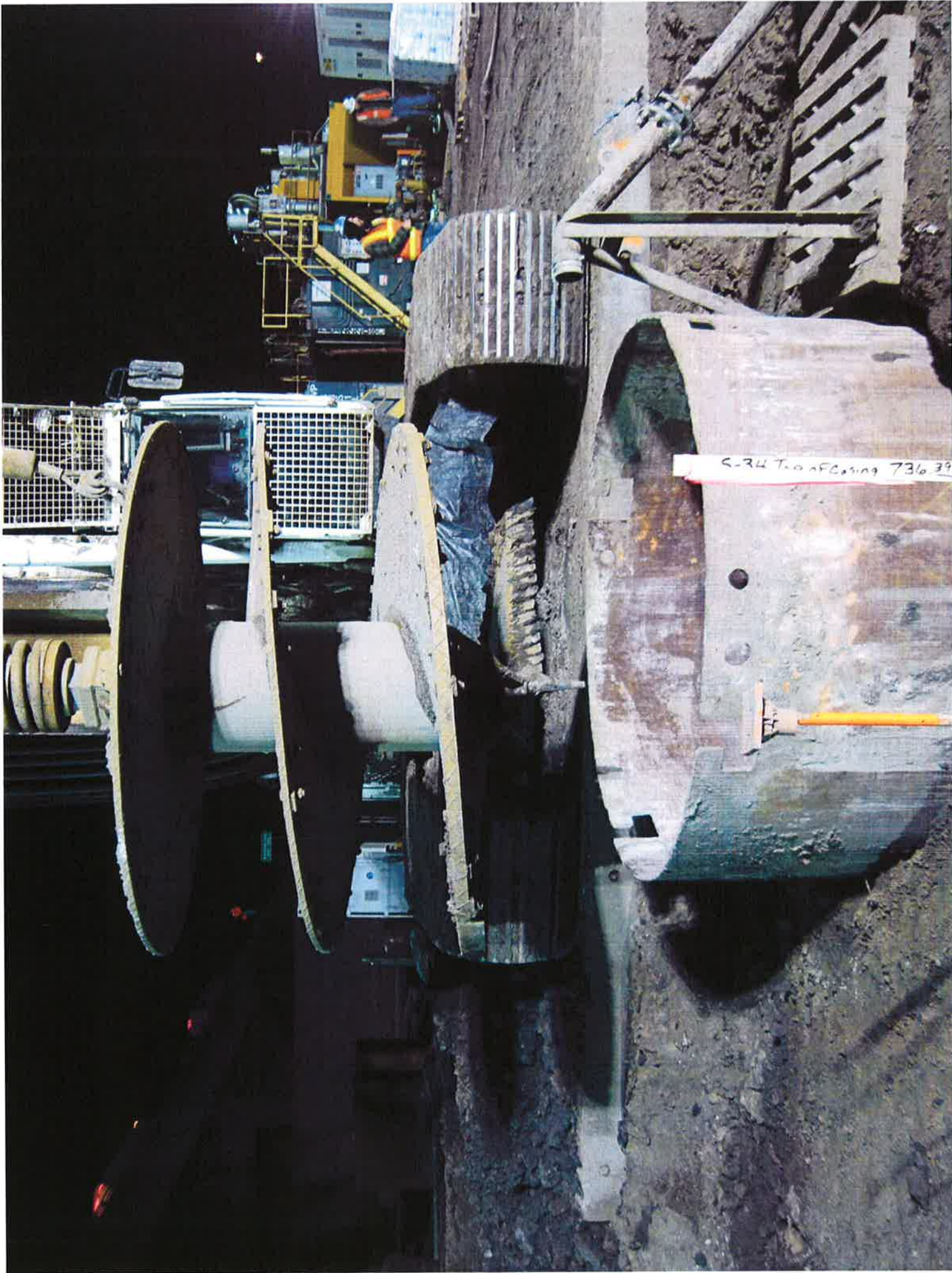


Figure 2



Drilling Auger and Temporary Casing.



Base Plate and Rebar Cage



Grout Line, Top.

Top Side of Base Plate showing rebar cage and grout lines.